CANADIAN RIVER PROJECT
Main Aqueduct--Central System
Amarillo Regulating Reservoir to Lubbock Regulating Reservoir
Hydraulic Performance Tests
Test Plan

INDEX

Written by R. B. Deffe, 1967
Transmittal letter, dated Nov 17, 1967, attached

CANADIAN RIVER MAIN AQUEDUCT--CENTRAL SYSTEM
Hydraulic Performance Tests

Part I. Purposes of Tests

A. To define the cause of water expulsion from pipe check structures and adjacent vents following routine discharge changes in the aqueduct and to record transient pressure data that can be used to investigate the problem. The recorded pressure data is expected to reveal whether or not the water expulsion problem is due to air vent action or resonant pressure transients in the pipeline or a combination of these factors.

B. To perform measurements of discharges and pressure heads in selected reaches of 72-inch, 66-inch, and 54-inch-diameter pipes for determination of hydraulic friction head and friction coefficients.

C. To check the accuracy of registration of the two flow meters in the Central System at Station 1884+50 and Station 5080+10 and to determine discharge coefficients of these insert-type flow tubes.

CANADIAN RIVER MAIN AQUEDUCT--CENTRAL SYSTEM
Hydraulic Performance Tests

Part II. Preparations for Tests

A. Preparations to be completed by the Project Construction Engineer's (PCE) Office prior to arrival of test personnel from the Chief Engineer's Office.

1. Refer to Drawing No. 662-D-665, with revision dated 1-3-67, and to the enclosed schematic diagram of the central system of the aqueduct.

2. Excavate down to the hydraulic test fittings, designated by the circle or square symbols on the enclosed diagram. Pressure recorders furnished from Denver (the Chief Engineer's Office) will be located adjacent to the shutoff valve in the excavations at each Station H (Drawing No. 662-D-665) location designated by a circle symbol. The excavations should be broad enough at the bottom to provide working room for the recorder and an operator. The recorders are 8 inches square by 2 feet long. The excavations at Station C locations should be sufficient to expose the corporation stop for connection of a pressure lead that will extend to a pressure recorder.

The Station H locations where water has been expelled from air vents present a problem because open excavations in which pressure recorders are to be located will fill with water. According to the letter dated March 3, 1967, from the PCE, water will be expelled during pressure surge measurements adjacent to Station H locations at aqueduct Stations 5446+17, 6702+99, 7233+16, 7716+73, 7789+73, and 8027+99. Installation of a 36-inch-diameter corrugated metal pipe at these locations is suggested as shown by the enclosed sketch. The 42-inch-diameter by 8 feet high instrument shelters specified on the sketch are similar to the shelters shown on Drawing No. 40-D-5734, page 138, Specifications No. DC-6000. These shelters weigh about 500 pounds each and will probably require use of a vehicle-mounted lifting boom to place the shelters as needed during test measurements. Three gage shelters will be required and can be furnished from Denver.

3. Purchase 1,000 feet of 1/2-inch-diameter, 80-psi, flexible polyethylene pipe, preferably 3 each, 400-foot coils as sold by Montgomery Ward or Sears Roebuck Stores. This pipe will be used to connect the Station C test fittings to pressure recorders located in the excavations at Station H. Necessary insert adapters and pipe fittings will be furnished from Denver.

4. Check the accuracy of the Amarillo and Lubbock regulating reservoirs water surface elevation readouts at the remote station and adjust as necessary.

5. Arrange for use of a voice communication system that will enable a test coordinator, located at a test reach along the aqueduct, to request changes in flow through the valve structure at Main Aqueduct Station 2118+57. This communication system will probably have to contain voice relay points due to the long distances involved.

6. Plan to have six radio-equipped vehicles, preferably pickup trucks, available during test measurements. Four of these vehicles must have 12-volt electrical systems and the generators (or alternators) and batteries should be in good condition. Clip leads will be connected to the vehicle batteries to power a 12-volt, d-c, 6-~~amp~~ watt, chart-drive motor in a pressure recorder. A vehicle will be needed at each of four pipe check or pipe stand structures in the reach under test. The test coordinator will need a radio-equipped vehicle. A person located at the Station 5080+10 Venturi structure throughout the surge and friction tests will need a radio-equipped vehicle. A seventh vehicle, preferably radio-equipped, will be needed by test personnel from Denver. Instrumentation needed to perform color-velocity discharge measurements will be operated in the seventh vehicle and a carry-all or panel-type vehicle will be most suitable.

7. Have two or more sets of engineer level equipment available.

8. Plan to provide the project personnel, listed on the following page, to perform test measurements.

9. Two hydraulic engineers from the Chief Engineer's Office will direct the test in cooperation with the test supervisor and test coordinator, and install and operate test equipment as necessary. For uniform reference purposes, one of the men from Denver will be designated "test director" and the other "assistant test director."

Number of persons	Activity
1	To operate the Main Aqueduct control valves. If it would be advantageous to operate the valves remotely from the Northern Control Station, where discharge readout is available, an operator will not be required at the Station 2118+57 valve structure.
1	To record manometer readings of differential-head produced by the Station 5080+10 Venturi structure flow tube.
8	Two each at four structures; one to tend the vehicle and radio and record times of water expulsion, the other person to operate a dual pressure recorder and monitor the time scale of the recorder. Also to move and reinstall the recorders for tests of three aqueduct reaches and to establish reference elevations of the recorders with engineer level equipment.
1	Test coordinator to maintain contact with all test personnel. If communication facilities permit, this will include contact with the person at the Station 5080+10 Venturi structure and the operator of the aqueduct control valves. If direct (voice-relay) communications are not possible, the discharge changes and manometer readings can be prescheduled.
1	Test supervisor to supervise all test functions and coordinate operations of the aqueduct for test purposes with personnel from Denver. Ideally, this man will be familiar with all ramifications of Main Aqueduct operation and guard against any operations that might endanger personnel, components of the aqueduct, or other property.
Unknown	Communications relay operators.

B. Preparations to be completed immediately prior to test measurements.

1. Meeting of PCE Office personnel, Region Office representatives as desired, and Denver Office personnel to finalize test plans, personnel requirements, equipment requirements, communications requirements, and to discuss any problems that might occur during proposed aqueduct operations for test purposes.

2. Instrument shelters will be placed at structures where water might be expelled along the first surge test reach of the aqueduct.

3. Denver Office personnel will assist with installation of test instruments and provide instructions for operation of all test equipment and for recording test data.

4. Plan to have near maximum capacity water storage in Amarillo Regulating Reservoir and to refill the reservoir to pretest water surface elevation after each test. Refilling can probably be accomplished by 12 hours or less of one pump operation of the Northern System.

CANADIAN RIVER MAIN AQUEDUCT--CENTRAL SYSTEM
Hydraulic Performance Tests

Part III. Pressure Surge Tests

A. Preliminary pressure surge test (Test No. ST-X).

1. Special purpose: To determine whether or not all needed data are being obtained and to allow time after this initial test for correction of any deficiencies.

2. Conditions: Pressure recorders will be in place and connected to the test fittings at the four farthest downstream structures at Stations 7715+13, 7788+04, 7919+51, and 8026+87. A manometer will be ready for readings at the Station 5080+10. Venturi structure. A test observer will be ready to record data at the Northern Control Station. Rate of flow recorders for the Station 5080+10 and Station 1884+15 flow meters will be in operation and time coordinated.

3. Procedures: Allow a flow of 0.25 cfs through the control valve structure during the night prior to the test. Open one valve, the valve passing 0.25 cfs, under manual control to pass 85 cfs or to full open position and hold for 2 hours. Then close the valve to pass 10 cfs and hold for 1 hour. The second valve to remain closed.

4. Observations: All standard observations and recordings outlined in Part VI, page 13, will be made from the time valve opening has started until the valve is closed. However, at the pipe checks and stands, pressure recordings and any water expulsion data will be continued until the test coordinator directs that data gathering be stopped.

5. Approximate volume of water transferred equals 22 AF.

6. Approximate time required for test operations equals 6 hours.

B. Pressure surge Test No. 1 (Test No. ST-1).

1. Conditions: Same as for preliminary surge tests.

2. Procedures: Allow a flow of 0.25 cfs through the valve structure during the night prior to the test. Open both control valves in unison, under manual control, until a discharge of 85 cfs is reached. Stop the valves at this position and hold for 1 hour. Close both valves completely in unison under manual control. Immediately start opening both valves under manual control to pass 40 cfs, hold for 1 hour, then start closing both valves down to 0.25 cfs.

3. Observations: All observations and recordings outlined in Part VI will be completed from the time two valve operation is started until the ~~one valve~~ operation is complete. However, observations at the four structures will be continued for about 1 hour after the ~~one valve~~ operation is completed.

4. Volume of water transferred equals 25 AF.

5. Time required for tests equals 8 to 9 hours.

6. Schedule: The day after Test No. ST-X.

C. Pressure surge Test No. 2 (Test No. ST-2).

1. This will be a repeat of Test No. ST-1, see III, B, above, except the dual channel pressure recorders will have been moved upstream and reinstalled at the following structures:

Pipe stand at Station 5744+73
Pipe check at Station 6701+93
Pipe check at Station 7232+00
Pipe stand at Station 7488+00

2. Volume of water transferred equals 25 AF.

3. Time required equals 8 to 9 hours.

4. Schedule: The day after friction Test No. 1.

D. Pressure surge Test No. 3 (Test No. ST-3).

1. Repeat of Test No. ST-1, see III, B, above, except the dual channel pressure recorders will have been moved and reinstalled at the following structures:

Pipe stand at Station 5107+02
Pipe stand at Station 5260+02
Pipe stand at Station 5355+98
Pipe check at Station 5445+05

2. Volume of water transferred equals 25 AF.

3. Time required equals 8 to 9 hours.

4. Schedule: The day after friction Test No. 2.

E. Pressure surge Test No. 4 (Test No. ST-4).

1. If time permits, this will be a test with the pressure recorders remaining at locations specified for Test No. ST-3 except one recorder will be moved downstream to the pipe stand at Station 5744+85. The purpose will be to determine the control valve operation that will result in minimum pressure surges for delivery of 7 cfs to the Plainview turnout. Standard surge test observations will be required.

2. Conditions and procedures: To be determined from experience gained during prior surge tests.

3. Observations: Same as for other surge tests.

4. Approximate volume of water transferred equals 10 AF.

5. Time required for test equals 8 hours.

6. Schedule: The day after Test No. ST-3.

CANADIAN RIVER MAIN AQUEDUCT--CENTRAL SYSTEM
Hydraulic Performance Tests

Part IV. Pipeline Hydraulic Friction and Flow Meter Tests

A. Friction Test No. 1 (Test No. FT-1) 54-inch-diameter pipe from Station 7716+73 to Station 7787+83.

1. Time: This test can be performed during the day that pressure recorders are being moved to prepare for Surge Test No. 2.

2. Dual purposes: Discharge measurements obtained during all the friction tests can also be used to check the accuracy of the Station 5080+10 flow meter recorder.

3. Conditions: A single tube manometer will be connected to the hydraulic test fitting at the upstream end and at the downstream end of the test reach. Reference elevations will be established for each manometer scale. A dye injection pressure tank and required fittings will also be connected to the upstream test fitting. A dye sampling connection leading to a recording fluorometer will be connected to the downstream test fitting. The color-velocity method will be used to determine discharge in the test reach. A low concentration of nontoxic dye (Pontacyl Pink-B) would be used for the discharge measurement.

4. Procedures: Provide a flow of 0.25 cfs in the aqueduct during the night prior to the test. Open both control valves under automatic control in unison to provide a discharge of 60 cfs. Hold this discharge for about 3 hours, then open both valves in unison to provide a discharge of 85 cfs and hold for 3 hours. Then close both valves in unison to reduce the discharge to 0.25 cfs.

5. Observations: Standard observations at the Northern Control Station and at the Station 5080+10 Venturi structure as called for in Part VI, page 13. Observations required at each end of the test reach, see Part VII, page .

6. Volume of water transferred equals 50 AF.

7. Time required for test equals 9 to 10 hours.

8. Schedule: The day after surge Test No. 1.

B. Friction Test No. 2 (Test No. FT-2) 54-inch-diameter pipe from Station 5357+09 to Station 5444+68.

1. Time: This test can be performed during the day that pressure recorders are being moved to prepare for surge Test No. 3.

2. Conditions: Same as for friction Test No. 1.

3. Procedures: Same as for friction Test No. 1.

4. Observations: Same as for friction Test No. 1.

5. Volume of water transferred equals 50 AF.

6. Time required for test equals 9 to 10 hours.

7. Schedule: The day after surge Test No. 2.

C. Friction Test No. 3 (Test FT-3) 66-inch-diameter pipe from Station 5108+18 to Station 5259+60.

1. Conditions: Same as for friction Test No. 1.

2. Procedures: Same as for friction Test No. 1.

3. Observations: Same as for friction Test No. 1.

4. Volume of water transferred equals 50 AF.

5. Time required for test equals 9 to 10 hours.

6. Schedule: The day after surge Test No. 4.

D. Friction Test No. 4 (Test No. FT-4) 72-inch-diameter pipe from Station 3045+32 to Station 3374+55.

1. Conditions: The pressure head manometers will be installed at each end of the test reach. However, color-velocity discharge measurements will be performed in the adjacent upstream pipe reach, that is, from the air vent at Station 2977+01 to the test fitting at Station 3043+73. To circumvent a deep excavation at the Station 2977+16 test fitting, the dye for color-velocity measurements will be injected through a pipe assembly and spring loaded valve that can be lowered down through the air vent and anchored at the top of the vent.

2. Procedures: Same as for friction Test No. 1.

3. Observations: Same as for friction Test No. 1.

4. Volume of water transferred equals 50 AF.

5. Approximate time required equals 9 to 10 hours.

6. Schedule: The day after friction Test No. 3.

Part V. Flow Meter Test

A. Accuracy and discharge coefficient test of the flow meter at Station 1884+50 (Test No. FM-1).

1. Conditions: A differential-head manometer will be connected to the flow meter. A dye injection pipe and valve assembly will be installed in the air vent at Station 1896+32 and a blind flange with stuffing box and dye sampling probe will be substituted for the air valve at Station 1973+86. This will damage the insulation on the air valve but it is assumed this will not be a serious problem.

2. Procedures: Based upon experience gained during previous tests, operate the control valves to establish a steady discharge of about 40 cfs. Hold this discharge for 2 hours. Then change the discharge to the maximum that the aqueduct will normally convey to Lubbock Reservoir and hold for 2 hours. Decrease the discharge to operational requirements.

3. Observations: Standard observations will be recorded at the northern control station, see Part VI, page 13. The observations listed in Part VIII, page 16, will be recorded at the Station 1884+50 flow meter.

4. Two or more discharge determinations will be made by the color-velocity method for each steady discharge.

5. Approximate volume of water transferred equals 48 AF.

6. Time required for test equals 10 hours.

7. Schedule: The second day after friction Test No. 4.

Part VI. Standard Observations for Pressure Surge Tests

A. The following measurements and observations shall be recorded during each surge test (all times to be recorded to the closest 1/2 minute).

1. At the Northern Control Station (or at the Station 2118+57 valve structure).

a. Test number and date.

b. Flow rate at Station 1884+50 flow meter prior to test.

c. Water surface elevation of Amarillo Regulating Reservoir at start of test and at 1 hour intervals until end of test.

d. Water surface elevation of Lubbock Regulating Reservoir at start of test and at 1 hour intervals until end of test.

e. Time that left control valve opening is started and stopped.

f. Same for right control valve.

g. Flow rate indicated by Station 1884+50 flow meter after valve travel is stopped for increasing flow. (Duplicates of the flow meter chart will be required as part of the test data.)

h. Repeat entries of e, f, and g for valve closings.

i. Repeat all entries for a second flow rate.

2. At the Station 5080+10 Venturi meter structure

a. Test number and date

b. Manometer reading and time at about 3 minute intervals while the differential head of the flow meter is increasing or decreasing. Manometer reading and time at 10 minute intervals for steady or fluctuating flow.

c. About four entries per day of manometer air temperature.

d. Duplicates of the Station 5080+10 flow meter charts will be needed as part of the test data.

3. At the four structures where dual pressure recorders will be connected to the test fittings upstream and downstream of the structure recorded the following:

a. Mark test number, date, structure station, and recorder elevation on the recorder strip chart.

b. With the recorder strip chart in motion (chart speed will be 1 inch per minute) mark a time reference on the chart and enter the time of day.

c. With a squeeze ball and tube connected to the third pressure channel of the recorder, make time pips on the strip chart at 10 minute intervals. Experience will reveal whether or not the chart speed is constant enough to omit these auxiliary time pips.

d. The second person at the structure will enter the following on a data sheet (only at pipe checks and adjacent vents where water might be expelled):

(1) Test number and date

(2) Structure station

(3) Time of and duration of water overflow (in some cases for both the pipe check and the vent).

Part VII. Observations Required for Combination Pipeline Friction and Flow Meter Calibration Tests

A. Standard observations will be required at the Northern Control Station (or the valve structure) and at the Station 5080+10 Venturi structure. (See Part VI, page 13.)

B. The following data will be recorded at each end of the friction test reach.

1. Date and test number.

2. Station of the test fitting. (See Drawing No. 662-D-665.)

3. Manometer scale reference elevation.

4. Manometer readings of pressure head and time of readings.

C. The test director and assistant will perform color-velocity discharge measurements in the test reach and record manometer readings.

Part VIII. Observations Required for Discharge Accuracy Tests of the Station 1884+50 Flow Meter

A. Standard observations will be required at the Northern Control Station or at the valve structure. (See Part VI, page 13.)

B. At the Station 1884+50 Venturi structure record:

1. Test number and date.

2. Differential head manometer reading and time of reading at about 10 minute intervals during steady flow conditions.

3. Air temperature at the manometer at about 2 hour intervals.

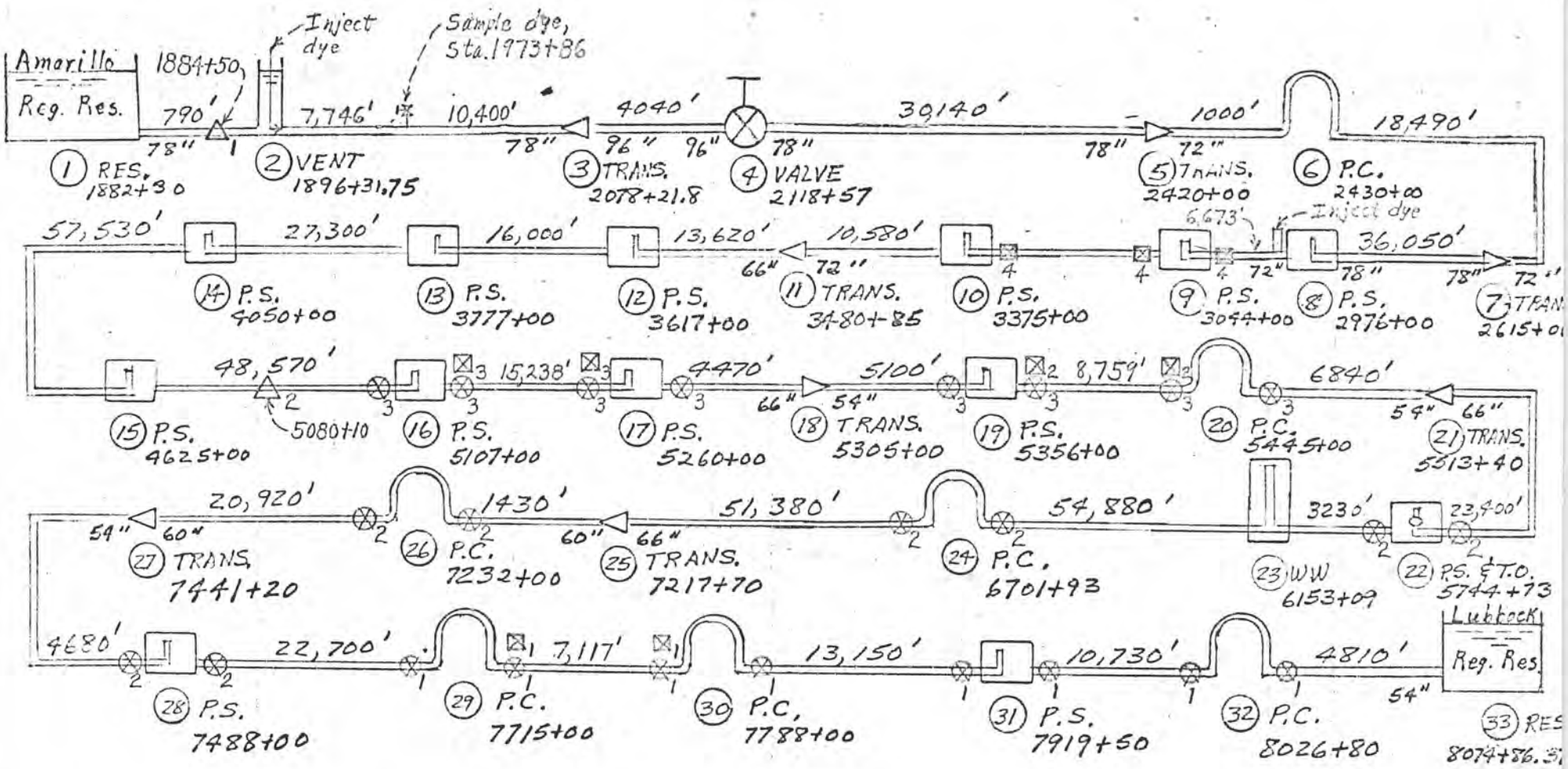
C. Color-velocity discharge measurements will be performed by the test director and assistant in the pipe reach from the Station 1896+32 vent structure to the air valve at Station 1973+86.

CANADIAN RIVER MAIN AQUEDUCT--CENTRAL SYSTEM
Hydraulic Performance Tests

Part IX. Approximate Time Schedule

A. Work days required for preparations and tests. Weekends will extend the total time period.

Work day	Activity
1	Meeting of all parties concerned and a check of required equipment and data sheets.
2	Move of personnel and equipment to test locations and start installation of instruments.
3	Finish installation work and prepare for first test.
4	Preliminary pressure surge test.
5	Pressure surge Test No. 1.
6	Move four pressure recorders and perform pipeline friction Test No. 1.
7	Pressure surge Test No. 2.
8	Move pressure recorders and perform pipeline friction Test No. 2.
9	Pressure surge Test No. 3.
10	Pressure surge Test No. 4.
11	Pipeline friction Test No. 3.
12	Pipeline friction Test No. 4.
13	Move equipment to upstream portion of Central System.
14	Station 1884+50 flow meter tests.
15	Gather all test results and equipment.



⊗$_1$ --Indicates points of connection of recorders for hydraulic tests to determine surges. Subscripts indicate individual test setups.

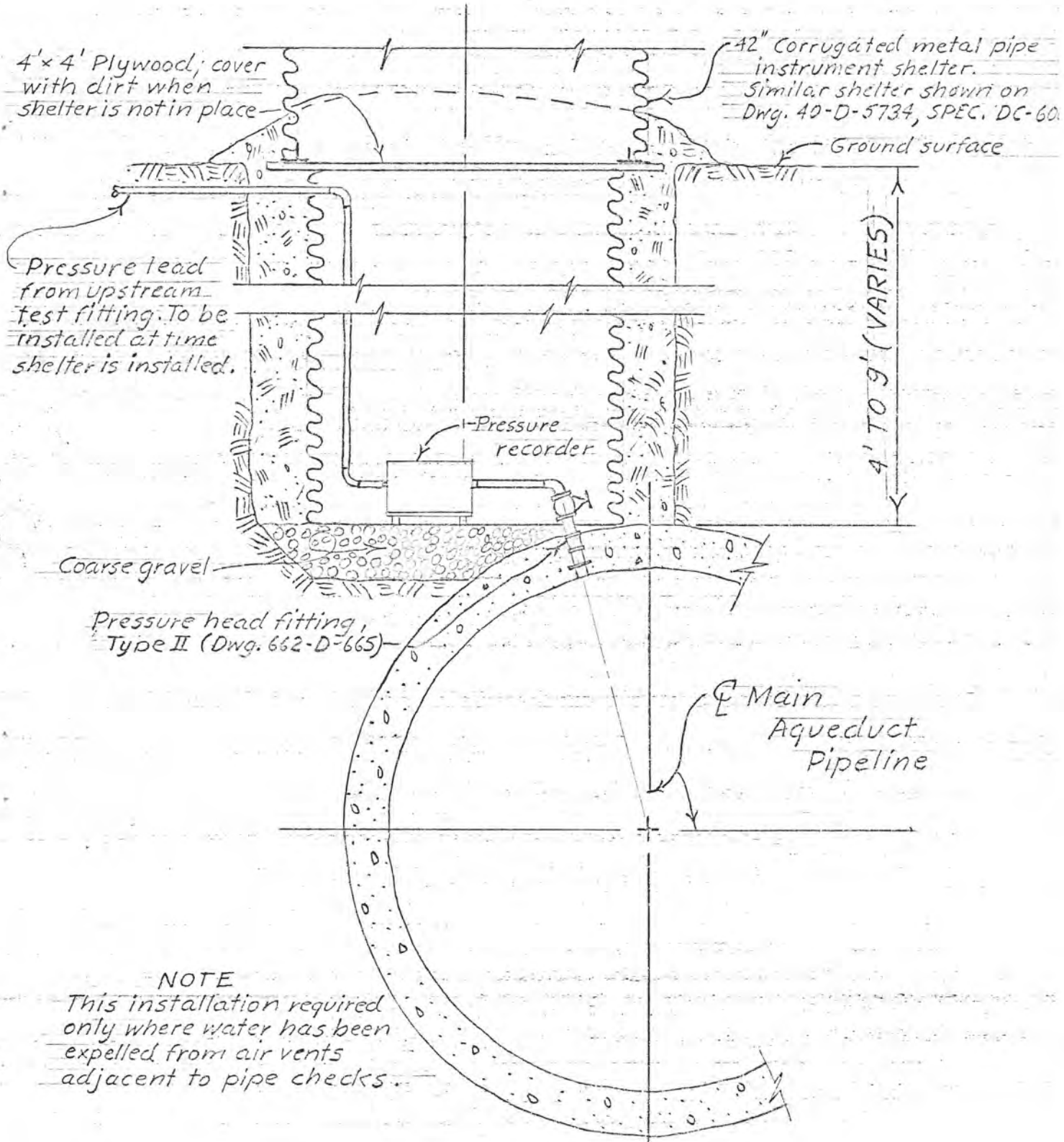
SCHEMATIC DIAGRAM
CANADIAN RIVER
WATER HAMMER PROBLEM

⊠$_1$ --Indicates points of connection for hydraulic tests to determine friction coefficients. Subscripts indicate individual test setups.

△$_{1,2}$ --Indicates a Venturi meter

D. F. N.

CANADIAN RIVER - MAIN AQUEDUCT
CENTRAL SYSTEM - HYDRAULIC TEST
PRESSURE RECORDER INSTALLATION



NOTE
This installation required only where water has been expelled from air vents adjacent to pipe checks.

ELEVATION
DOWNSTREAM VIEW

Form 7-1596
(11-61)
Bureau of Reclamation

520.

CANADIAN RIVER

OFFICIAL FILE COPY

Date	Surname	Code
11/9	Cutter	293
9	Peterka	29
9	Wirth	213
9	Burnett	790
11/15	Barton	236
11/15	Rippon	230
11/16	Hall	211

D-293

NOV 17 1967

To: Project Construction Engineer, Amarillo, Texas

From: Chief Engineer

Subject: Hydraulic performance tests--Canadian River Aqueduct from Amarillo Reservoir to Lubbock Reservoir (Central System)--Canadian River Project, Texas (your letter dated September 14, 1967)

Subsequent to receipt of your letter, we learned through telephone conversation that there is not sufficient water in Amarillo Regulating Reservoir to perform the hydraulic tests. About 300 acre-feet of water will be transferred to Lubbock Regulating Reservoir if all planned tests are performed. If the Northern System of the aqueduct is available to refill Amarillo Reservoir by late November as presently indicated, the performance tests could be started about December 1, 1967. However, because of possible interruptions of test activities by winter weather we prefer to perform this work next spring. We can furnish personnel and equipment for either time that you recommend. It would be possible to perform the surge test measurements, which require the maximum number of personnel, early in December 1967, and perform the pipeline friction and flowmeter tests next spring.

A plan for the hydraulic performance tests of the Central System of the Main Aqueduct is enclosed. We will be glad to receive any suggested changes of the plan that you deem advisable. We request that you furnish us with information relative to the time required to establish steady discharge in the Central System for the hydraulic friction and flowmeter tests as outlined in the plan. We will furnish data sheets for all test data except the information to be recorded at the Northern Control Station as called for in Part VI, A, of the plan. We suggest that your office prepare a data sheet or sheets, similar to those used in each pumping plant during the hydraulic test of the Northern System, for the purpose of recording information called for in Part VI, A, of the test plan.

A motor generator unit with 1,000 or more watts capacity, 115-volts ac, will be needed during the tests. Please advise whether or not you can have such a unit available. If not, we can ship a generating unit with other test equipment.

GPO 851770

We plan to send two hydraulic engineers to your office to finalize plans for the hydraulic performance tests, direct test operations, and assist with test measurements. These men would arrive at your office 3 days prior to the start of test measurements to accomplish the activities scheduled in Part XX of the test plan.

Wm. H. Wolf
Acting Chief Engineer

Enclosure

Copy to: Regional Director, Amarillo, Texas, Attention: S-200, S-400
(with enclosure)

Blind to: 230
236 (with enclosure)
250
293

RBDexter:jad-s